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SYNTHESIS AND MOLECULAR STRUCTURE OF (3-(PPH3)-3,3-(NO3)-3,1,2---ETC(U)

AUG 79 Z DEMIDOWICZ, R G TELLER

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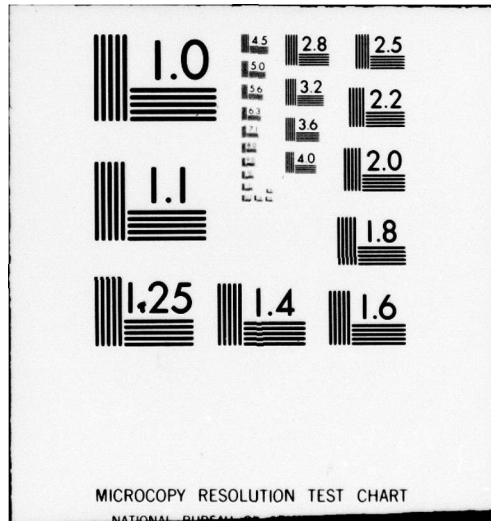
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[3-(PPh<sub>3</sub>)-3,3-(NO<sub>2</sub>)-3,1,2-RhC<sub>2</sub>B<sub>9</sub>H<sub>11</sub>], a Versatile Metallocarborane Reagent.

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by

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### SUMMARY

The action of nitric acid or  $\text{NO}_2/\text{N}_2\text{O}_4$  mixture on  $[3,3-(\text{PPh}_3)_2\text{-H-}3,1,2\text{-RhC}_2\text{B}_9\text{H}_{11}]$  affords the nitratorhodacarborane  $[3-(\text{PPh}_3)\text{-}3,3-(\text{NO}_3)\text{-}3,1,2\text{-RhC}_2\text{B}_9\text{H}_{11}](\text{I})$  whose structure has been determined by X-ray crystallography, triclinic, space group P1,  $a = 12.592(5)$ ,  $b = 16.382(8)$ ,  $c = 17.059(6)$  Å,  $\alpha = 75.74(4)^\circ$ ,  $\beta = 105.34(3)^\circ$ ,  $\gamma = 120.05(3)^\circ$ ,  $z = 2$ . The latter species has been shown to be a useful precursor in the synthesis of other rhodacarborane derivatives.

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In continuation of our studies of the chemical properties of metallo-carborane complexes<sup>1-4</sup> we have found that treatment of  $[3,3-(PPh_3)_2-3-H-3,1,2-RhC_2B_9H_{11}]^1$  with excess nitric acid in dichloromethane or  $NO_2/N_2O_4$  in benzene, at room temperature, affords an air-stable red complex(I) isolated in good yield (ca. 70%) by column chromatography (silicagel- $CH_2Cl_2$ ) and crystallization.

The i.r. spectrum of (I), as a nujol mull, showed absorptions characteristic of terminal B-H bonds and coordinated triphenylphosphine. The  $^{31}P\{^1H\}$  nmr spectrum<sup>5</sup> of (I) in  $CDCl_3$  showed a doublet centered at +36.1 ppm,  $J_{Rh-P} = 168.5$  Hz. The  $^{11}B\{^1H\}$  nmr spectrum,<sup>6</sup> also in  $CDCl_3$ , showed resonances at -25.7, -9.2, -3.1 and +11.8 of relative intensities 1:2:4:2. Also no signal attributable to a Rh-H group could be detected in the  $^1H$  nmr spectrum of (I).

Microanalytical data for crystalline (I) proved inconclusive: apparently because of solvent loss; however the presence of Rh, N, P and B in the ratio 1:1:1:9 was clearly indicated. In a further attempt to elucidate the nature of (I) we noted that (I) reacts with  $PPh_3$  and either  $H_2$  or hydrochloric acid in THF solution to quantitatively generate  $[3,3-(PPh_3)_2-3-X-3,1,2-RhC_2B_9H_{11}]$  ( $X = H^1$  or  $Cl^{7,8}$  respectively). Further, it has been shown that transition metal nitrate complexes can be obtained by the action of nitric acid on platinum-metal phosphine complexes.<sup>9</sup> Accordingly we tentatively formulated (I) as  $[3-(PPh_3)-3,3-(NO_3)-3,1,2-RhC_2B_9H_{11}]$  in which a closo-rhodacarborane cage and a bidentate nitrate ligand acting as a three-electron donor towards rhodium are present. This formulation was subsequently confirmed by an X-ray crystallographic study.

#### Crystal Data

$[P(C_6H_5)_3]NO_3RhC_2B_9H_{11} \cdot 3CH_2Cl_2$   $M = 814.4$ , triclinic, space group  $P1$ ,  $a = 12.592(5)$ ,  $b = 16.382(8)$ ,  $c = 17.059(6)$  Å,  $\alpha = 75.74(4)^\circ$ ,  $\beta = 105.34(3)^\circ$ ,



$\gamma = 120.05(3)^\circ$ ,  $z = 2$ ,  $\mu(\text{MoK}_\alpha) = 7.29 \text{ cm}^{-1}$ . Data were collected on a Picker FACS-I four circle diffractometer at room temperature with the crystal sealed in a thin-walled capillary to prevent solvent loss. The structure was solved by standard Patterson and Fourier techniques. Severe disorder in the solvent molecules has prevented a satisfactory refinement of the structure and at present the agreement factor stands at 0.123 (3497 reflections).

The molecule is illustrated in the figure along with some pertinent bond distances and angles. As postulated the complex consists of a rhodium atom bonded to a  $\text{C}_2\text{B}_9\text{H}_{11}^{-2}$  anion, triphenylphosphine and nitrate ligands with the closo- $\text{RhC}_2\text{B}_9\text{H}_{11}$  fragment in its usual distorted icosahedral geometry. The nitrate group is bound in an apparently symmetrically bidentate fashion with an average Rh-O bond length of  $2.20(1) \text{ \AA}$ . This value is  $0.1 \text{ \AA}$  larger than various Rh(III)-O bonds in complexes containing carbonato or acetylacetonato ligands<sup>10</sup> but does compare favorably with Rh(III)-O distances in complexes with weakly bound water molecules ( $2.24(1)$  and  $2.28(1) \text{ \AA}$ ).<sup>11</sup> The only other metallo-carborane with a metal-oxygen bond is  $[\text{3,3-(PPh}_3)_2\text{-3-(HSO}_4\text{)-3,1,2-RhC}_2\text{B}_9\text{H}_{11}]$  with a Rh-O distance of  $2.245(8) \text{ \AA}$ .<sup>12</sup>

$[\text{3-(PPh}_3\text{)-3,3-(NO}_3\text{)-3,1,2-RhC}_2\text{B}_9\text{H}_{11}](\text{I})$  has proved to be an extremely useful precursor in the synthesis of previously inaccessible rhodacarborane derivatives. For example (I) reacts with CO gas and hydrochloric acid in THF at room temperature to afford, in 85% yield, air-stable  $[\text{3-(PPh}_3\text{)-3-(CO)-3-Cl-3,1,2-RhC}_2\text{B}_9\text{H}_{11}](\text{II})$  characterized by elemental analysis, i.r. and n.m.r. spectroscopy.<sup>13</sup> Previous attempts in this laboratory to prepare (II) by direct reaction of CO with the previously documented  $[\text{3,3-(PPh}_3)_2\text{-3-Cl-3,1,2-RhC}_2\text{B}_9\text{H}_{11}]$ <sup>7,8</sup> have failed.

Complex (I) also reacts with  $\text{PPh}_3$  in diethylether at room temperature to give, in 81% yield, orange  $[\text{3,3-(PPh}_3)_2\text{-3-(NO}_3\text{)-3,1,2-RhC}_2\text{B}_9\text{H}_{11}](\text{III})$  charac-

terized by elemental analysis<sup>14</sup> and i.r. and n.m.r. spectroscopy. In particular the  $^{31}\text{P}\{^1\text{H}\}$  n.m.r. spectrum of (III) at room temperature in  $\text{CDCl}_3$  shows, in addition to a doublet centered at +28.0 ppm ( $J_{\text{Rh-P}} = 133.5$  Hz) attributed to (III), resonances characteristic of uncoordinated triphenylphosphine and complex (I). Thus (III) apparently exhibits behavior in solution similar to that reported for  $[\text{3,3-(PPh}_3)_2\text{-3-(HSO}_4\text{)-3,1,2-RhC}_2\text{B}_9\text{H}_{11}]$ .<sup>12</sup>

Finally we note that (II) reacts with  $\text{PPh}_3$  in THF at room temperature to afford  $[\text{3,3-(PPh}_3)_2\text{-3-Cl-3,1,2-RhC}_2\text{B}_9\text{H}_{11}]$ <sup>7,8</sup> in 81% yield and that (III) reacts with either  $\text{H}_2$  or hydrochloric acid, also in THF at room temperature, to give  $[\text{3,3-(PPh}_3)_2\text{-3-X-3,1,2-Rh(C}_2\text{B}_9\text{H}_{11})]$  ( $\text{X} = \text{H}^1$  in 79% yield, or  $\text{X} = \text{Cl}^{7,8}$  in 90% yield respectively).

#### Acknowledgments

We thank Professor F. Anet for the use of  $^{11}\text{B}$  n.m.r. facilities; C. A. O'Con, Dr. D. Busby and R. T. Baker for assistance in obtaining n.m.r. spectra and Dr. R. Grey for preliminary research. This work was supported in part by National Science Foundation (Grant No. CHE78-05679) and by the Office of Naval Research.

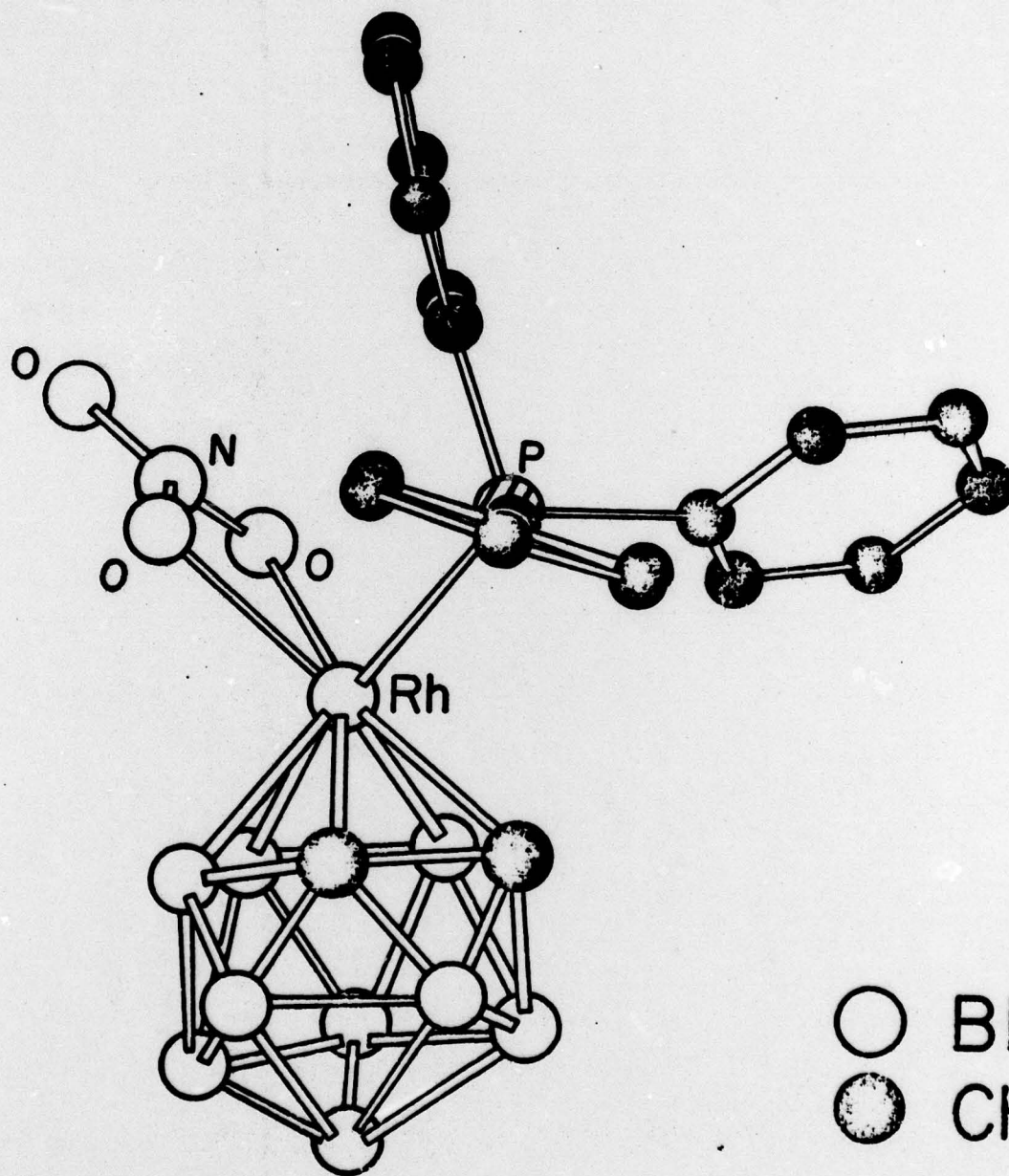


## References

1. T. E. Paxson and M. F. Hawthorne, J. Am. Chem. Soc., 1974, 96, 4674.
2. E. L. Hoel and M. F. Hawthorne, J. Am. Chem. Soc., 1974, 96, 4676.
3. C. W. Jung and M. F. Hawthorne, J.C.S. Chem. Commun., 1976, 499.
4. E. H. S. Wong and M. F. Hawthorne, Inorg. Chem., 1978, 17, 2863.
5. All  $^{31}\text{P}$  nmr spectra are with reference to external  $\text{D}_3\text{PO}_4$ .
6. All  $^{11}\text{B}$  nmr spectra are with reference to external  $\text{BF}_3 \cdot \text{OEt}_2$ .
7. A. R. Siedle, J. Organometallic Chem., 1975, 90, 249.
8. R. Grey and M. F. Hawthorne; unpublished results.
9. P. B. Critchlow and S. D. Robinson, Inorg. Chem., 1978, 17, 1896 and references therein.
10. a) N. W. Alcock, J. M. Brown and J. C. Jeffrey, J.C.S. Dalton, 1976, 583.  
b) S. Krogsrud, S. Komiya, T. Ito, J. A. Ibers and A. Yamamoto, Inorg. Chem., 1976, 15, 2798.
11. a) P. D. Frisch and G. P. Khare, J. Am. Chem. Soc., 1978, 100, 8267.  
b) J. T. Mague, Inorg. Chem., 1973, 12, 1249.
12. W. C. Kalb, R. G. Teller and M. F. Hawthorne; J. Am. Chem. Soc., in press.
13. Analysis: Found; C = 45.8, H = 4.6, Cl = 6.7, B = 17.6, P = 5.6, Rh = 18.2%.  $\text{C}_{21}\text{H}_{26}\text{B}_9\text{ClO}_3\text{PRh}$  requires C = 45.0, H = 4.7, Cl = 6.3, B = 17.3, P = 5.5, Rh = 18.3%. i.r. spectrum, as a nujol mull, showed  $\nu(\text{CO})$  at ca.  $2062\text{ cm}^{-1}$ .  $^{31}\text{P}\{^1\text{H}\}$  nmr spectrum in  $\text{CDCl}_3$  showed a doublet centered at +39.6 ppm,  $J_{\text{Rh-P}} = 107.4\text{ Hz}$ .
14. Analysis: Found; C = 55.6, H = 5.3, N = 1.6, P = 7.4, B = 11.6, Rh = 12.3%.  $\text{C}_{38}\text{H}_{41}\text{B}_9\text{NO}_3\text{P}_2\text{Rh}$  requires C = 55.5, H = 5.0, N = 1.7, P = 7.5, B = 11.5, Rh = 12.5%.



Figure 1 A molecular plot of (I). Some distances (averaged from two unique molecules) follow: Rh-O 2.20(1) Å, Rh-P 2.38(1) Å, N-O 1.22(1) Å, Rh-C 2.14(2) Å, Rh-B 2.14(3) Å, C-C 1.88(7) Å, C-B 1.80(2) Å, B-B 1.82(2) Å.





1. Positional (in Fractional Coordinates) and Thermal<sup>a</sup> Parameters for (the Non-group Atoms of) 3-PPh<sub>3</sub>-3,3-NO<sub>3</sub>-3,1,2-RhC<sub>2</sub>B<sub>9</sub>H<sub>11</sub>

Atom	$10^4x$	$10^4y$	$10^4z$	$B(A^2)$
Rh <sup>b</sup>	0	0	0	c
C(1)	-521(34)	744(26)	589(22)	2.7(8)
C(2)	-587(34)	-417(24)	1136(21)	2.5(8)
B(4)	-1639(35)	-1227(24)	422(21)	1.8(7)
B(5)	-2305(43)	-1269(31)	1203(26)	2.6(10)
B(6)	1576(38)	22(27)	1283(23)	1.9(8)
B(7)	-2017(34)	-692(24)	-425(20)	0.9(7)
B(8)	-3217(40)	-1393(28)	169(24)	2.4(9)
B(9)	-3244(47)	-677(34)	717(29)	3.6(11)
B(10)	-1974(65)	704(49)	170(41)	5.5(17)
B(11)	-1296(37)	477(26)	-456(22)	1.3(8)
B(12)	-2886(46)	-356(32)	-340(27)	3.0(10)
N	940(34)	-807(26)	-608(23)	4.5(8)
O(1)	369(25)	-220(18)	-1097(15)	3.4(6)
O(2)	922(21)	-875(16)	119(14)	2.3(5)
O(3)	1253(25)	-1151(19)	-994(17)	4.2(6)
P	1864(17)	1441(13)	-26(11)	c
Rh'	3908(8)	5631(5)	5620(4)	c
C(1)'	2688(37)	5909(27)	6052(22)	3.0(9)
C(2)'	3072(38)	6557(28)	4999(24)	3.7(9)
B(4)'	2803(40)	5603(29)	4475(24)	2.4(9)
B(5)'	1672(42)	6073(31)	4281(26)	2.8(9)
B(6)'	1675(39)	6300(28)	5239(24)	2.2(9)
B(7)'	2197(40)	4545(29)	5111(25)	2.2(9)
B(8)'	1150(44)	4761(32)	4336(27)	3.4(10)
B(9)'	274(48)	5239(42)	4811(33)	5.4(15)
B(10)'	996(45)	5112(33)	5940(28)	3.1(10)
B(11)'	1990(64)	4742(47)	6071(41)	4.0(17)
B(12)'	656(62)	4155(46)	5335(33)	7.0(15)
N'	5047(31)	4646(23)	6334(22)	3.3(8)
O(1)'	4823(23)	4766(18)	5657(16)	3.0(6)
O(2)'	4822(23)	5086(17)	6769(14)	3.0(5)
O(3)'	5617(26)	4230(19)	6784(16)	4.5(6)
P'	5697(18)	7044(15)	5690(11)	c

## 2. Anisotropic Temperature Factors<sup>d</sup>

<u>Atom</u>	<u><math>10^4 \beta_{11}</math></u>	<u><math>10^4 \beta_{22}</math></u>	<u><math>10^5 \beta_{33}</math></u>	<u><math>10^5 \beta_{12}</math></u>	<u><math>10^5 \beta_{13}</math></u>	<u><math>10^5 \beta_{23}</math></u>
Rh	126(7)	70(4)	48(2)	44(4)	16(3)	-8(2)
Rh'	114(6)	67(4)	63(3)	40(4)	9(3)	-4(2)
P	113(19)	68(10)	46(8)	44(11)	4(8)	-2(6)
P'	140(23)	106(14)	49(8)	33(14)	41(10)	7(8)

## 3. Rigid-Group Parameters<sup>e</sup>

<u>Group</u>	<u>x</u>	<u>y</u>	<u>z</u>	<u>Phi</u>	<u>Theta</u>	<u>Rho</u>	<u><math>B(A^2)</math></u>
Phenyl 1	.309(2)	.132(2)	-.037(2)	-2.98(2)	-2.19(1)	-2.82(3)	3.7(4)
Phenyl 2	.274(2)	.194(2)	.090(1)	2.86(2)	-2.57(1)	1.66(2)	2.3(3)
Phenyl 3	.150(2)	.231(2)	-.079(1)	0.43(2)	-2.36(1)	-1.76(2)	3.1(3)
Phenyl 4	.719(2)	.687(1)	.601(2)	-2.98(2)	2.19(1)	2.73(2)	3.4(4)
Phenyl 5	.623(2)	.791(2)	.479(1)	2.85(2)	2.53(1)	-1.58(2)	3.8(4)
Phenyl 6	.580(2)	.764(2)	.649(1)	0.46(2)	2.40(1)	1.80(2)	3.0(4)

- Standard deviations in the least significant figures are given in parentheses. All phenyl moieties were refined as rigid groups with C-C 1.39 and C-H 1.00 Å.
- The position of the atom was fixed in the least squares process.
- Anisotropic thermal parameter.
- The form of the anisotropic thermal ellipsoidal is:  $\exp[-(\beta_{11}h^2 + \beta_{22}k^2 + \beta_{33}l^2 + 2\beta_{12}hk + 2\beta_{13}hl + 2\beta_{23}kl)]$ .
- x, y, and z are the coordinates of the origin of the rigid group and phi, theta, and rho the rotation angles.



Selected Distances (in Å) and Angles (in degrees) in  
3-(PPh<sub>3</sub>)-3,3-(NO<sub>3</sub>)-3,1,2-RhC<sub>2</sub>B<sub>9</sub>H<sub>11</sub>·3CH<sub>2</sub>Cl<sub>2</sub>

1. Distances

<u>Molecule 1</u>		<u>Molecule 2</u>
Rh-C(1)	2.16	2.14
Rh-C(2)	2.09	2.18
Rh-B(4)	2.18	2.07
Rh-B(7)	2.19	2.12
Rh-B(11)	2.05	2.23
Rh-N(1)	2.67	2.58
Rh-O(1)	2.19	2.21
Rh-O(3)	2.20	2.22
Rh-P	2.35	2.41
P-C(11)	1.90	1.73
P-C(21)	1.79	1.79
P-C(31)	1.83	1.91
N-O(1)	1.26	1.19
N-O(2)	1.20	1.25
N-O(3)	1.22	1.21
C(1)-C(2)	1.87	1.90
C(1)-B(4)	1.78	1.82
C(1)-B(5)	1.92	1.78
C(1)-B(6)	1.81	1.73
C(2)-B(6)	1.77	1.85
C(2)-B(10)	1.76	1.84
C(2)-B(11)	1.83	1.65
B(4)-B(5)	1.72	1.85
B(4)-B(7)	1.58	1.72
B(4)-B(8)	1.81	1.82
B(5)-B(6)	1.86	1.76
B(5)-B(8)	1.83	1.89
B(5)-B(9)	1.81	1.90



Molecule 1 (cont'd)

Molecule 2 (cont'd)

B(6)-B(9)	1.93	1.88
B(6)-B(10)	2.03	1.91
B(7)-B(8)	1.77	1.71
B(7)-B(11)	1.65	1.85
B(7)-B(12)	1.50	1.83
B(8)-B(9)	1.69	2.03
B(8)-B(12)	1.60	1.84
B(9)-B(10)	2.16	1.91
B(9)-B(12)	1.86	2.01
B(10)-B(11)	1.74	1.60
B(10)-B(12)	1.82	1.90
B(11)-B(12)	1.80	1.78

2. Angles

P-Rh-O(1)	87	90
P-Rh-O(3)	94	84
P-Rh-C(1)	111	107
P-Rh-C(2)	83	87
P-Rh-B(4)	146	112
P-Rh-B(7)	161	160
P-Rh-B(11)	101	147
O(1)-Rh-C(1)	150	152
O(1)-Rh-C(2)	155	153
O(1)-Rh-B(4)	111	107
O(1)-Rh-B(7)	92	89
O(1)-Rh-B(11)	104	113
O(3)-Rh-C(1)	148	102
O(3)-Rh-C(2)	101	148
O(3)-Rh-B(4)	92	158
O(3)-Rh-B(7)	115	112
O(3)-Rh-B(11)	157	94
O(1)-Rh-O(3)	60	56
O(1)-N-O(2)	115	125
O(1)-N-O(3)	110	118
O(2)-N-O(3)	134	115

Molecule 1 (cont'd)Molecule 2 (cont'd)

Rh-P-C(11)	112	115
Rh-P-C(21)	120	118
Rh-P-C(31)	107	102
C(11)-P-C(27)	100	107
C(11)-P-C(31)	108	109
C(21)-P-C(31)	110	105

- a) Estimated standard deviations in bond lengths: Rh-P 0.01, Rh-O 0.02, Rh-N 0.03, Rh-C 0.03, Rh-B 0.03, N-O 0.05, C-C 0.07, C-B 0.08, B-B 0.08 Å; and in bond angles: P-Rh-O, P-Rh-C, P-Rh-B 1°, O-Rh-C, O-Rh-B 2°, O-N-O 3°.



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18. SUPPLEMENTARY NOTES		
19. KEY WORDS (Continue on reverse side if necessary and identify by block number) Synthesis, Structure, Nitratorhodacarborane		
20. ABSTRACT (Continue on reverse side if necessary and identify by block number) The action of nitric acid or NO <sub>2</sub> /N <sub>2</sub> O <sub>4</sub> mixture on [3,3-(PPh <sub>3</sub> ) <sub>2</sub> -3-H-3,1,2-RhC <sub>2</sub> B <sub>9</sub> H <sub>11</sub> ] affords the nitratorhodacarborane [3-(PPh) <sub>3</sub> -3,3-(NO <sub>3</sub> )-3,1,2-RhC <sub>2</sub> B <sub>9</sub> H <sub>11</sub> ](I) whose structure has been determined by X-ray crystallography, triclinic, space group P1, a = 12.592(5), b = 16.382(8), c = 17.059(6) Å, α = 75.74(4)°, β = 105.34(3)°, γ = 120.05(3)°, z = 2. The latter species has been shown to be a useful precursor in the synthesis of other rhodacarborane derivatives. BETA GAMMA ZETA ALPHA		

**APPENDIX**



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